## Appendix A    STEP BY STEP TEST PROCEDURES

### Appendix A.1  INTRODUCTION

This appendix presents step by step test procedures for each safety device.  The appendix provides forms for obtaining and recording all necessary data for each safety device being tested.  It begins with tables that allow a thorough definition of the testing agency/personnel, responsible parties at the site, and boiler/burner data.  This base data is followed by overarching requirements for safety testing.  This information is then followed by one sheet for each device being tested to be used by the testing agency personnel as a check list and data form.

### Appendix A.2    BASIC INFORMATION

**VISN:** _____

**VA Medical Center:** _____

**Contact Name:** _____

**Phone:** _____

**Email:** _____

**Evaluators:** _____

**Date:** _____

**Individuals in Attendance:**

**Boiler and Burner Description**

| Boiler # | |
|---|---|
| **Manufacturer:** | |
| **Model and Capacity:** | |
| **Serial #: National Board No.:** | |
| **Typical Operating Pressure:** | |
| **Design Pressure:** | |
| **Date of Manufacture** | |
| **Boiler Controls:** | |
| **Burner** | |
| **Manufacturer:** | |
| **Type of burner:** | |
| **Fuels:** | |
| **Date of Manufacture:** | |

September 2008

## Appendix A.3 GENERAL REQUIREMENTS FOR TESTING

The following test procedures make certain assumptions that are listed below.
- After each test, equipment should be returned to normal operating condition and the boiler should be fired to confirm its operability.
- "Jumping" means disabling the switch electrically
- Any electric "jumper" application requires that all power to the device being "jumpered" be shut off.
- All pressure gages used in a test must be recently calibrated.
- Any valve that disables a safety device should be lockable only in the operating position.
- The setpoint is the value at which the switch indicator is set. The trip point is the actual value at which the switch activates. Some language used in the test procedures assumes that the setpoint equals the trip point.
- Potentiometers used as safeties should be evaluated to determine if they are also used as the control. This is not acceptable.

## Appendix A.4 Detailed Test Procedures - Checklists

## BOILER DEVICES

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## Checklist for Liquid Relief Valve on Oil Pump Set (LRVOPS)

| Item | Make | Capacity (gal/hr) | Range | LRVOPS Setpoint | Oil Supply Pressure | Correct Installation |
|------|------|-------------------|-------|-----------------|---------------------|----------------------|
| LRVOPS | | | | | | |
| Pressure Gage | | | | | | |

*Setpoint should be less than the max allowable pump pressure and less than 10 psig above normal regulated oil supply pressure.

* Liquid relief should not be used as a backpressure regulator.
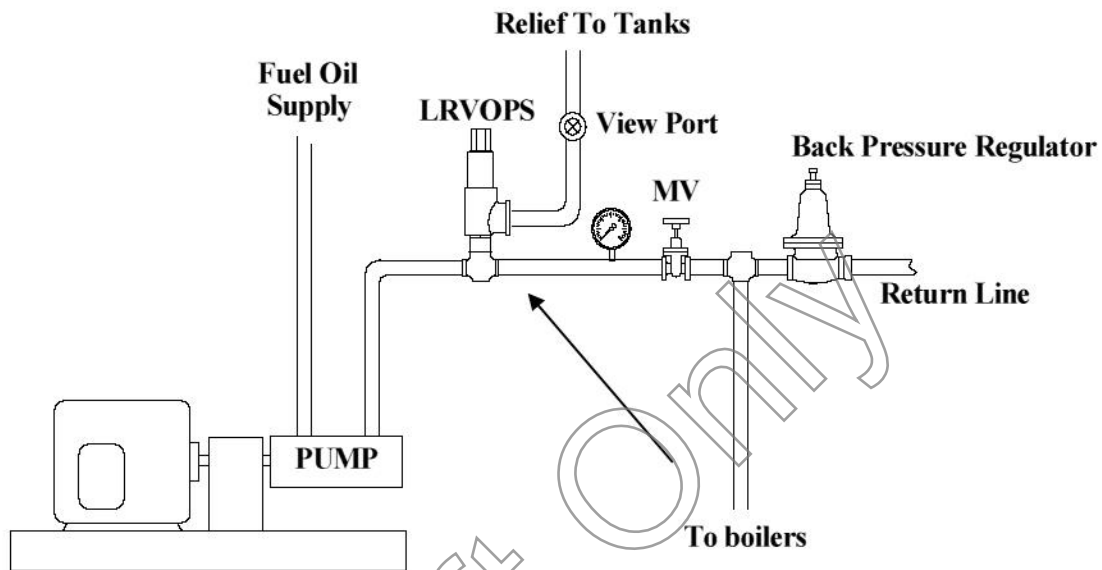


- Slowly close manual valve in oil line after relief valve or raise pressure regulator set pressure until relief valve lifts (use view port to determine if valve is open).
- The pressure should rise no more than 10 psig above normal regulated oil supply pressure.

| Result | Y/N | Pressure |
|--------|-----|----------|
| Did the relief valve work correctly? | | |
| What was the safety valve relief pressure? | | |
| Did valve re-seat? | | |
| View port in place to view oil flow thru relief valve? | | |
| Is a back pressure regulator present? | | |

Comment:

## Checklist for Liquid Relief Valve on Economizer (LRVE)

| Item | Make | Capacity (gal/hr) | Range | LRVE Setpoint | Feedwater Pressure | Correct Installation |
|------|------|-------------------|-------|---------------|--------------------|--------------------|
| LRVE | | | | | | |
| Pressure Gage | | | | | | |

*Setpoint should be less than the max allowable economizer pressure and more than maximum feedwater pressure.

| Item | Make | Max Stack Temp | MAWP |
|------|------|----------------|------|
| Economizer | | | |
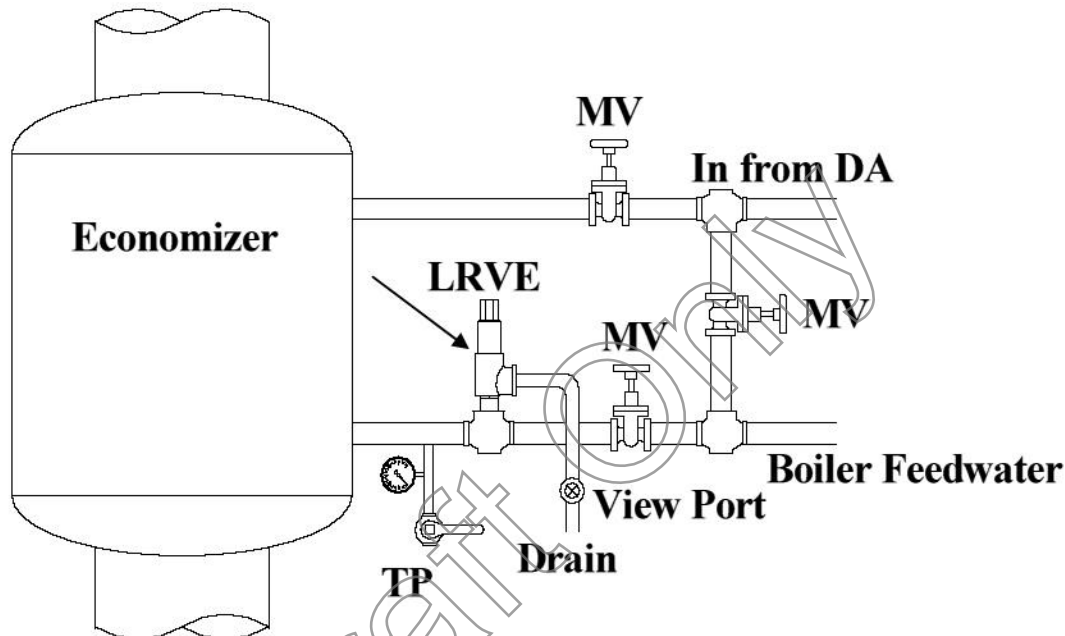


- With boiler offline use manual valves to isolate economizer and relief valve. Use hydrostatic tester to raise pressure and open relief valve (use view port to determine when valve is open). DO NOT RAISE PRESSURE MORE THAN ALLOWABLE ECONOMIZER PRESSURE!
- An alternate method is to raise economizer pressure by operating boiler with isolation valves closed.

| Result | Y/N | Pressure |
|--------|-----|----------|
| Did the LRVE work correctly? | | |
| What was the safety valve relief pressure? | | |
| Maximum allowable economizer pressure? | | |
| What is the re-seat pressure? | | |
| View port in place to view water flow thru relief valve? | | |

Comment:

## Checklist for Control Air Pressure Interlock (CAPI)

| Item | Make | Range (psig) | Switch Setpoint | Regulated Pressure | Required Pressure | Correct Location Y/ N |
|------|------|------|------|------|------|------|
| CAPI | | | | | | |
| Pressure Gage | | | | | | |

*Setpoint should be more than pressure required to actuate any pneumatic control device.
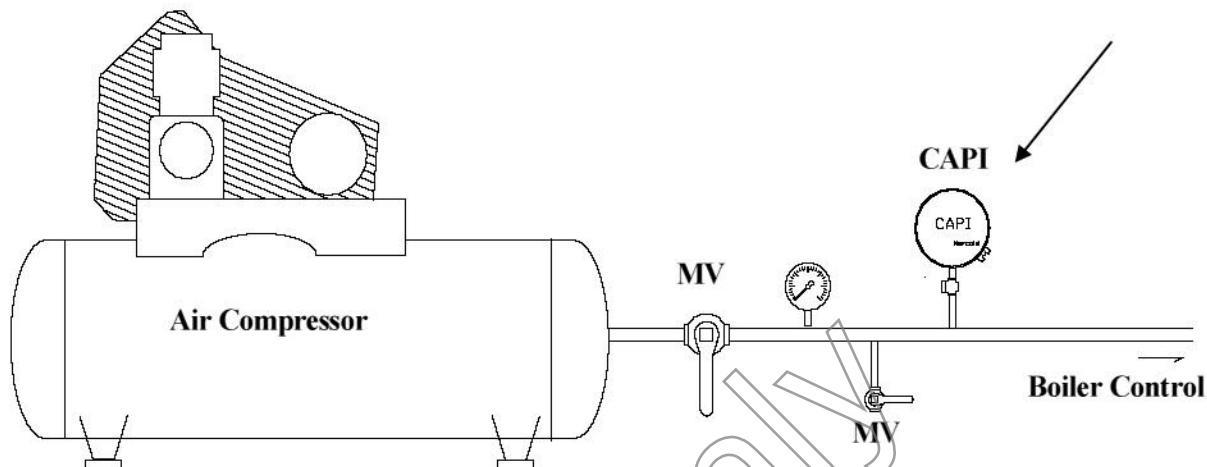


- Slowly close manual test valve to lower air supply pressure. Observe the pressure at which boiler shuts down. DO NOT LOWER PRESSURE BELOW REQUIRED PRESSURE TO ACTUATE ANY PNEUMATIC CONTROL DEVICE!

| Result | Y/N | Trip Point |
|--------|-----|-----------|
| Did the CAPI work correctly? | | |
| Is a lockable manual test valve in place as shown in figure? | | |
| What was the interlock trip point? | | |
| Is the setpoint higher than pressure required to actuate any pneumatic control device | | |

Comment:

# Checklist for Propane Pilot Backup System

- Connect and/or align propane system to boiler.
- Attempt to light boiler FIRING ON FUEL OIL.

| Result | Y/N |
|---|---|
| Is system in place and operable? | |

Comment:

## Checklist for Carbon Monoxide and Combustible Gas Alarms in the Boiler Plant

| Item | Make | Number of Alarms | Alarm Setpoint | Test Gas Y/N | Correct Location Y / N |
|------|------|------------------|----------------|--------------|------------------------|
| Combustible Alarm | | | | | |
| CO Alarm | | | | | |

*CO setpoint should be 50 ppm or less.

*Combustible setpoints should be 10% or less of the LEL.

*Test gasses for CO and combustibles should be 225-250 ppm.

*Location and number of CO and combustible sensors determined by VA directive.

- Supply proper test in accordance with manufacturers recommendation to test alarms.

| Result | Y/N |
|--------|-----|
| Did the combustibles alarm work correctly? | |
| Did the CO alarm work correctly? | |
| Are the number and locations of the sensors adequate? | |

Comment:

# Checklist for Outside Air Damper Interlock (OADI)

- If OADI exists, close outside air damper and prove that interlock shuts off boiler.
- If OADI does not exist measure fixed air intake area (fixed area required is 1.5 times the total combustion inlet air area for all boilers).

| Result | Y/N | Manufacturer |
|---|---|---|
| Is there adequate FIXED opening to supply combustion air? | | |
| If there is not adequate fixed opening, is there and OADI? | | |
| If OADI exists, did it work? | | |

*Fixed intake area should be 1.5 times intake area for all boilers.

Comment:

## Checklist for Low Water Alarm and Cutoffs on Boiler
## (LWA/LWCO/ALWCO)

| Item | Make | Float / Probe | Correct Installation |
|---|---|---|---|
| LWA | | | |
| LWCO | | | |
| ALWCO | | | |

*Independent shunt switches should be installed for each LWCO
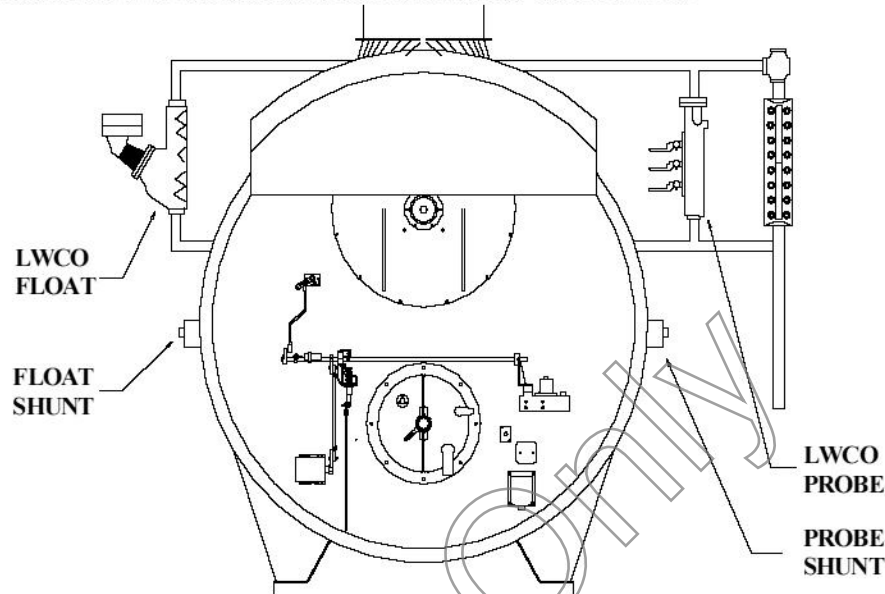


- IN PERFORMING TEST NEVER LET WATER LEVEL LEAVE SIGHT GLASS!!!
- Drain sight glass without draining alarm column and quickly close drain valve. Water level should quickly rise in sight glass indicating good communication with tank.
- With boiler in manual at low fire, close the feedwater valve to generate a slow drain. You may "crack" the blowdown valve but do not exceed a drain rate of 1 inch per minute. Use water level in sight glass to observe alarm point. The alarm should sound first.
- Continue to drain until the primary cutoff activates.
- If shunt exists verify that it **ONLY** isolates the LWCO.
- Jumper or shunt the primary cutoff, restart the boiler, and set up drain as described above.
- Continue the drain until the secondary cutoff activates.

| Result | Y/N | Water Level |
|---|---|---|
| Did the LWA work correctly? Record Level. | | |
| Did the Primary cutoff work correctly? Record Level. | | |
| Did the secondary cutoff work correctly? | | |
| Was the alarm point above the primary and secondary cutoff point? | | |
| Overall, did alarm and 2 low water cutoffs work correctly? | | |

Comment:

## Checklist for High Water Alarm on Boiler (HWAB)

| Item | Make | Float / Probe | Correct Installation |
|------|------|---------------|----------------------|
| HWA  |      |               |                      |

*Sight glass water level should be 1" or more below top of sight glass at alarm.
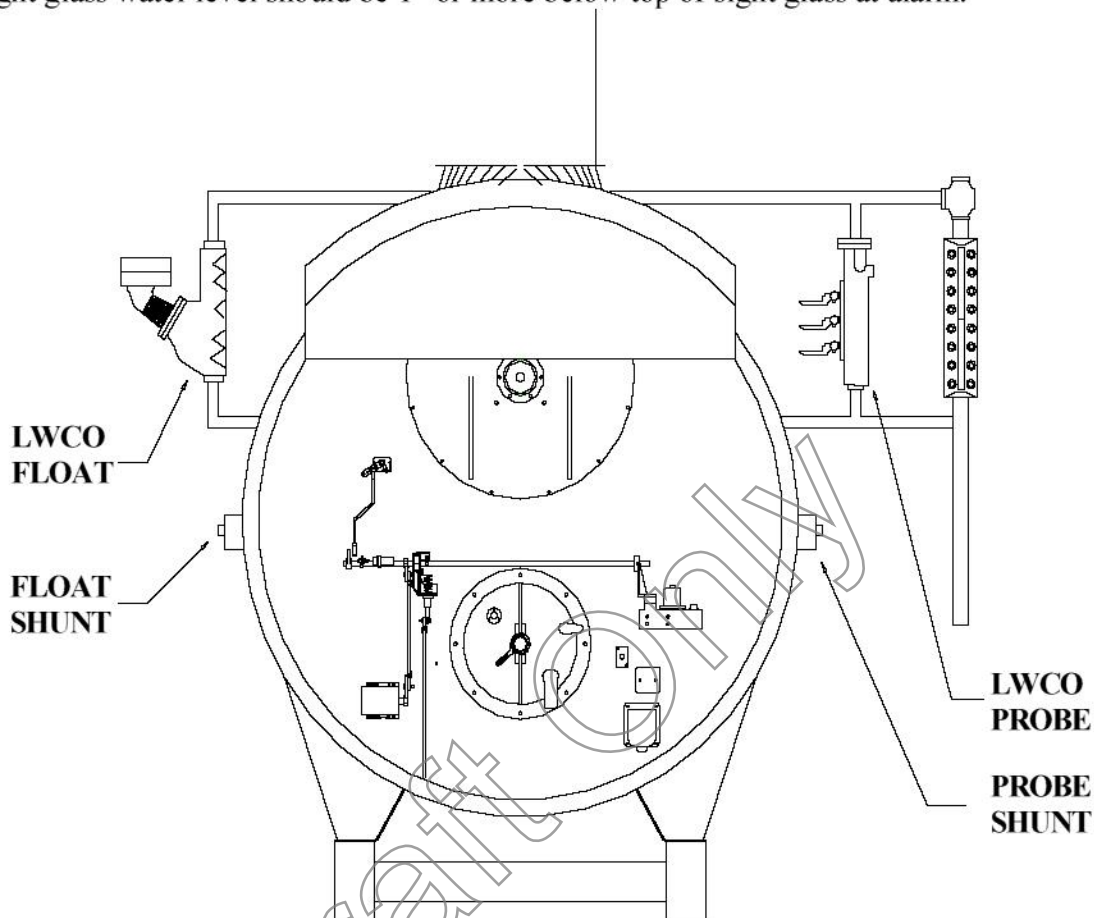
LWCO
FLOAT

FLOAT
SHUNT

LWCO
PROBE

PROBE
SHUNT

- Drain sight glass without draining alarm column and quickly close drain valve. Water level should quickly rise in sight glass indicating good communication with tank.
- With boiler off, open the bypass feedwater valve to fill the boiler. Use water level in sight glass to observe alarm point. The alarm should sound before water level leaves sight glass. DO NOT ALLOW WATER LEVEL TO LEAVE SIGHT GLASS
- Close the bypass on feedwater line

| Result | Y/N | Water Level |
|--------|-----|-------------|
| Did the alarm work correctly? | | |
| What was the water level in sight glass at alarm point? | | |

Comment:

## Checklist for Recycle and Non-Recycle Boiler Steam Pressure Limit Switches (RBSPLS & NRBSPLS)

| Item | Make | Range (psig) | Switch Setpoint | Normal Steam Pressure (psig) | Lowest SVB Setpoint (psig) | Correct Setpoint Y / N |
|---|---|---|---|---|---|---|
| RBSPLS | | | | | | |
| NRBSPLS | | | | | | |
| Pressure Gage | | | | | | |

*RBSPLS setpoint should be 10 psig or more of normal steam pressure.
*NRBSPLS setpoint should be 5 psig or more of the RBSPLS setpoint & 5 psig or more less than the lowest SVB setpoint.

---

- Never exceed the boiler MAWP during this test.
- Place boiler in minimum fire and manually close the steam supply valves from the boiler.
- Raise the steam pressure slowly by firing the boiler.
- Raise until RBSPLS activates – record activation pressure in table below.
- Jumper the recycle switch out of the circuit.
- Fire boiler and raise the steam pressure slowly.
- Raise until NRSBPLS activates – record activation pressure in table below .

---

| Result | Y/N | Pressure |
|---|---|---|
| Did the RBSPLS work correctly? Record Pressure. | | |
| Did the NRSBPLS work properly? Record Pressure. | | |

Comment:

## Checklist for Steam Safety Valves on Boiler (SVB)

| Item | Make | Capacity (Lb/hr) | Range | SVB Setpoint | Normal Steam Pressure | Correct Installation / Capacity |
|---|---|---|---|---|---|---|
| SVB 1 | | | | | | |
| SVB 2 | | | | | | |
| SVB 3 | | | | | | |
| Pressure Gage | | | | | | |

*SVB1 should be set 5 psig higher than NRBSPLS & 10 psig below boiler MAWP.

*SVB2 should be set 5 psig or higher than SVB1 & 5 psig or more below boiler MAWP.

| Item | MAWP (psig) | Capacity (lb/hr) |
|---|---|---|
| Boiler | | |
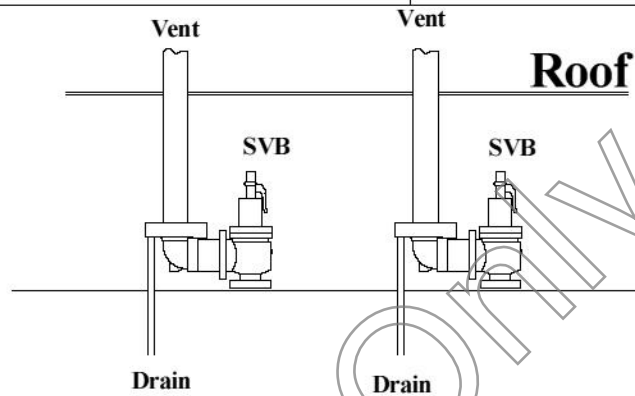


- NEVER ALLOW BOILER PRESSURE TO EXCEEDE MAWP
- With boiler off, jumper recycle and non-recycle steam pressure switches.
- Close the steam supply valves from the boiler and test the drains on the safety valve drip pan ells by pouring water into them and noting that water flows freely. Unstop drains before proceeding.
- Raise the steam pressure slowly by firing the boiler at low fire.
- Note the pressure that the first & second safety valve opened. (may require increasing firing rate).
- Place boiler in high fire and determine if steam pressure rises with both SVB open.
- Shut boiler off and note the pressure that the safety valves close.

| Result | Y/N | Lift (P) | Reseat (P) |
|---|---|---|---|
| Did the first SVB correctly? Record Pressure. | | | |
| Did the second SVB work correctly? Record Pressure. | | | |
| Did the third SVB work correctly? Record Pressure. | | | |
| Maximum pressure observed during accumulation test? | | | |
| Is SVB vent plumbing adequate? | | | |

*Max lift pressure of 3% higher than rated lift pressure. Blowdown should be less than the greater of 2 psig or 2% of the set pressure, and shall not exceed 6% of set pressure.

*Maximum accumulation pressure seen should not exceed 110% of highest SVB setpoint and never exceed boiler rated pressure.

Comment:

# Checklist for Low Fuel Gas Pressure Cutoff Switch (LFGPCS)

| Item | Make | Range (inwc/psig) | Switch Setpoint (inwc/ psig) | Regulated Pressure (inwc/psig) | Correct Location Y / N |
|------|------|-------------------|------------------------------|--------------------------------|------------------------|
| LFGPCS | | | | | |
| Pressure Gage | | | | | |

*LFGPCS must be downstream of PRV and upstream of AFGSOV with a setpoint of 80% or higher than regulated pressure.



In low fire, throttle upstream fuel valve slowly until switch trips the boiler offline due to low fuel pressure but NO LOWER THAN 80% OF REGULATED PRESSURE

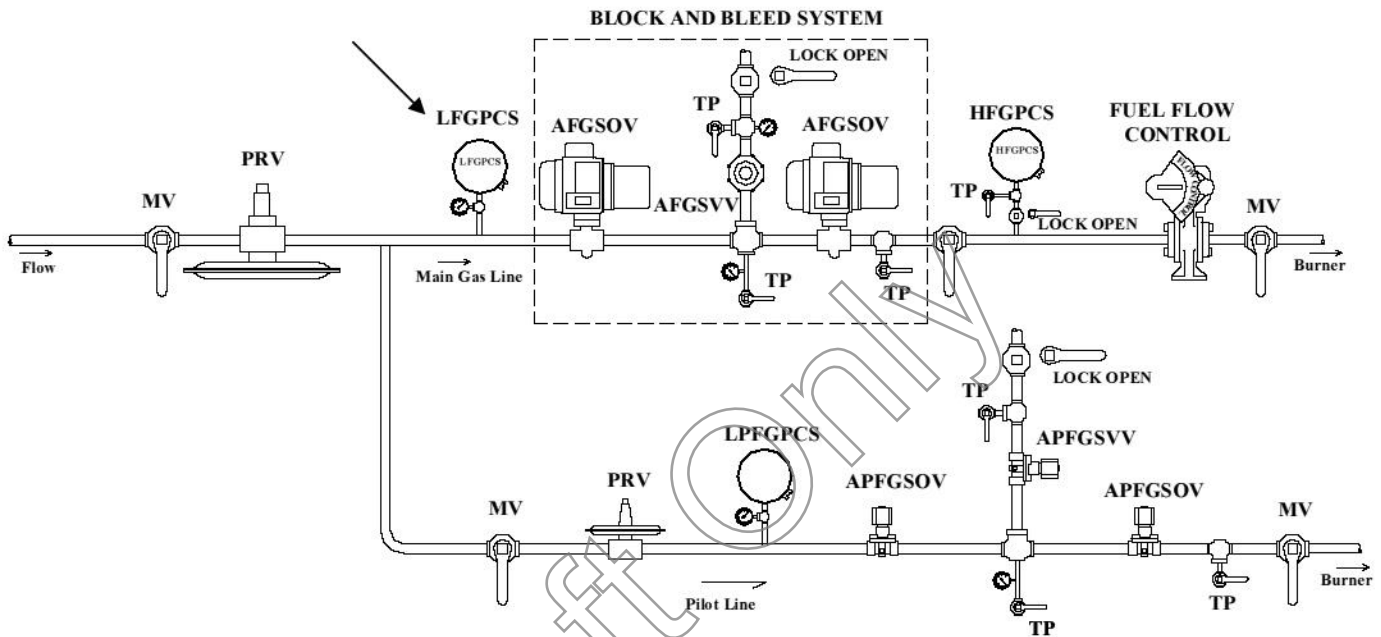| Result | Y/N | Pressure |
|--------|-----|----------|
| Did the switch work correctly? Record pressure. | | |
| Is switch trip point 80% or more of regulated pressure? | | |

Comment:

## Checklist for High Fuel Gas Pressure Cutoff Switch (HFGPCS)

| Item | Make | Range (inwc/psig) | Switch Setpoint (inwc/ psig) | Regulated Pressure (inwc/psig) | Correct Location Y / N |
|---|---|---|---|---|---|
| HFGPCS | | | | | |
| Pressure Gage | | | | | |

*HFGPCS must be downstream of PRV and upstream of flow control with a setpoint of less than 120% of regulated pressure.
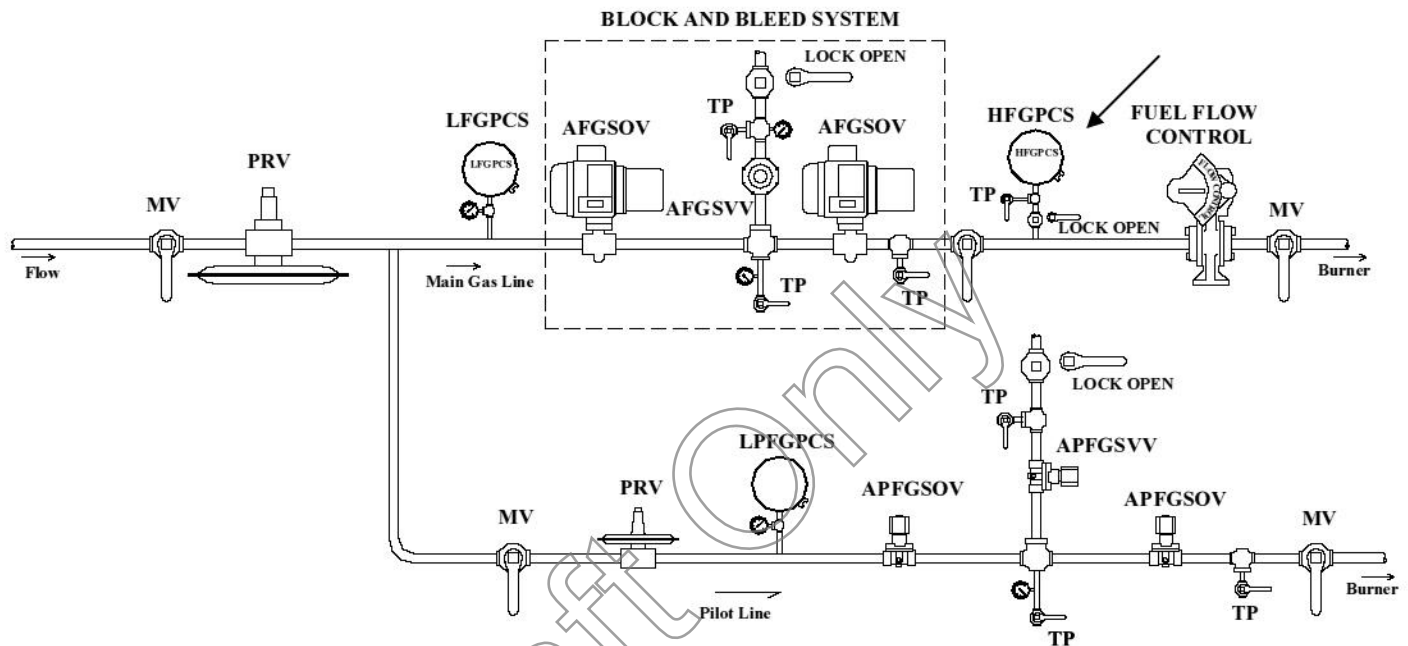


- With boiler in low fire close lockable manual valve isolating the HFGPCS.
- Open test port between lockable manual valve and HFGPCS and pressurize with compressed air or nitrogen.
- Slowly raise pressure until switch trips boiler offline due to high test gas pressure, BUT NO HIGHER THAN 120% OF REGULATED PRESSURE.

| Result | Y/N | Switch Trip Point |
|---|---|---|
| Did the switch work correctly? | | |
| Are manual test valves and test port valves in place as shown? | | |
| What was the switch trip point? | | |
| Is switch trip point 120% or less of regulated pressure? | | |

Comment:

## Checklist for Automatic Fuel Gas Shutoff Valves and Solenoid Vent Valve Seat Leakage (AFGSOV & AFGSVV) – Main Gas Line

| Item | Make | Range (inwc/psig) | Correct Installation  Y/N |
|------|------|-------------------|---------------------------|
| AFGSOV | | | |
| AFGSVV | | | |
| Pressure Gage | | | |
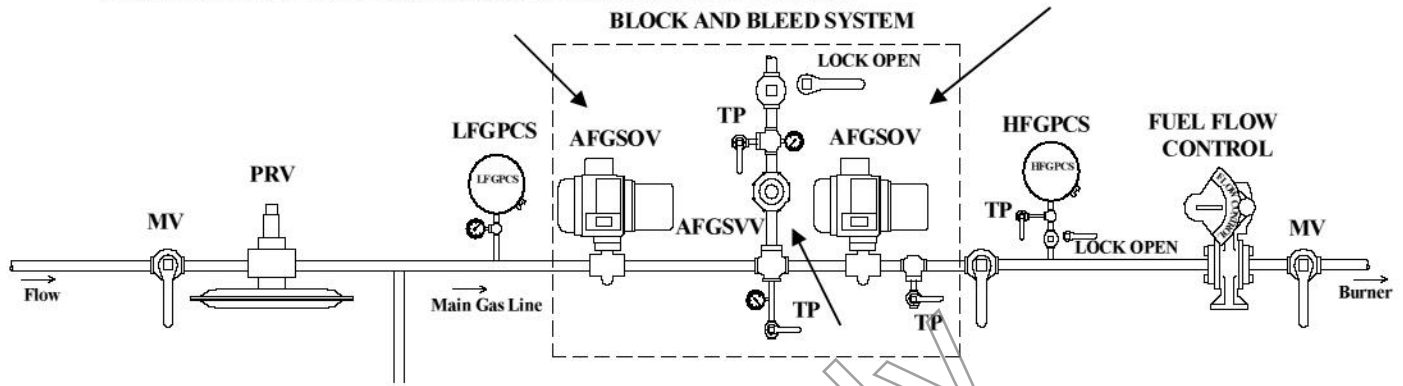
*Maximum allowable leak rate is zero bubbles in 2 minutes.



- Verify all test port valves are closed and manual valve in vent line is open.  Connect flexible tubing to the 3 test ports as shown.
- The test utilizes placing the flex line no more than ¼ inch in water.  This test can be accelerated by pressurizing the flex line before submerging in water.
- With the boiler in low fire, close manual lockable valve in vent line and open test port valve in vent line.  Verify that no bubbles appear.
- Provide regulated gas pressure (or more) before upstream AFGSOV and between AFGSOVs.
- Using the two test ports in the main gas line and the test port in the vent line, open the test port valves and observe water for sign of bubbles for 2 minutes.
- If no bubbles appear, the respective valve is not leaking.
- Open and lock manual vent valve and shut boiler off and verify that the pressure between AFGSOV is atmospheric.

| Result | Y/N |
|--------|-----|
| Did upstream AFGSOV leak? | |
| Did downstream AFGSOV leak? | |
| Did AFGSVV leak? | |
| Did AFGSVV open with boiler off | |

Comment:

## Checklist for Automatic Pilot Fuel Gas Shutoff Valves and Automatic Pilot Fuel Gas Solenoid Vent Valve Seat Leakage (APFGSOV & APFGSVV) – Pilot Line

| Item | Make | Range (inwc/PSIG) | Correct Installation  Y/N |
|------|------|-------------------|---------------------------|
| APFGSOV |  |  |  |
| APFGSVV |  |  |  |
| Pressure Gage |  |  |  |
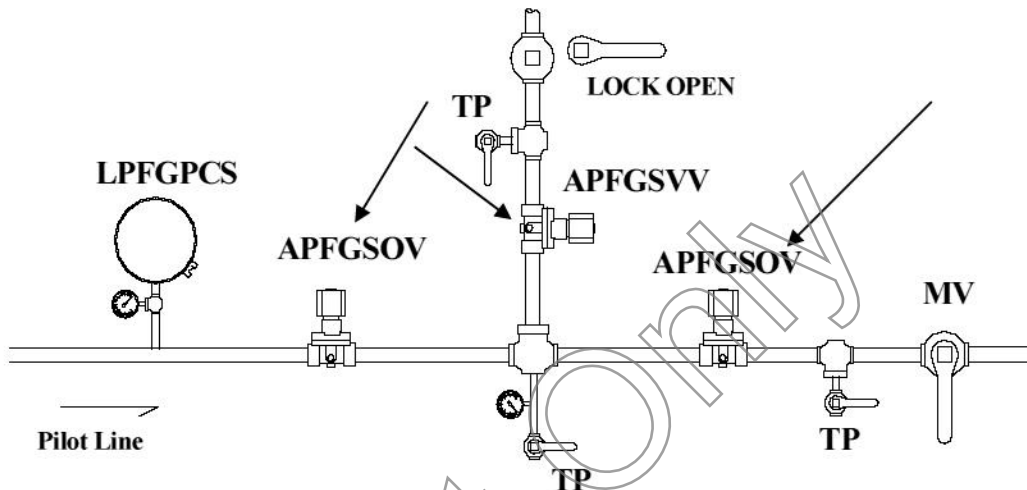
*Maximum allowable leak rate is zero bubbles in 2 minutes.



- Verify all test port valves are closed and manual valve in vent line is open.  Connect flexible tubing to the 3 test ports as shown.
- The test utilizes placing the flex line no more than ¼ inch in water.  This test can be accelerated by pressurizing the flex line before submerging in water.
- With the boiler in low fire, close manual lockable valve in vent line and open test port valve in vent line.  Verify that no bubbles appear.
- Provide regulated gas pressure (or more) before upstream APFGSOV and between APFGSOVs.
- Using the two test ports in the main gas line and the test port in the vent line, open the test port valves and observe water for sign of bubbles for 2 minutes.
- If no bubbles appear, the respective valve is not leaking.
- Open and lock manual vent valve and shut boiler off and verify that the pressure between APFGSOV is atmospheric.

| Result | Y/N |
|--------|-----|
| Did upstream APFGSOV leak? |  |
| Did downstream APFGSOV leak? |  |
| Did APFGSVV leak? |  |
| Did APFGSVV open with boiler off |  |

Comment:

# Checklist for Proof of Closure on Automatic Fuel Shutoff Valves (POC-AFGSOV) – Natural Gas

| Item | Make |
|---|---|
| POC-AFGSOV | |

*Switch should open with a very slight opening of the valve.
*Switches should be wired in series.

- Close manual fuel valve downstream of AFGSOV.  Perform the following test on each AFGSOV separately.
- Remove cover on both automatic shut off valves to provide access to two wires connected across proof of closure switch. Can also access wires in appropriate junction box.  Disconnect both leads from switch going to control circuit.
- Temporarily connect the two wires that were disconnected from the POC switch in order to electrically bypass the switch.
- Start boiler and verify that switch opens with a very slight opening of the valve by measuring resistance across switch.
- Shut boiler down and disconnect two wires going to control circuit.  Try to start boiler and verify that the boiler does not allow ignition sequence to begin.
- Repeat procedure for switch on 2nd valve.

| Result | Y/N |
|---|---|
| Is POC present in both valves? | |
| Did either valve being open allow the boiler to fire? | |
| Did both switches open with very slight opening of valve? | |

Comment:

# Checklist for Flame Scanner-for main flame out (FSMFO)

| Item | Make | Model | UV or IR | Self-Checking Y/N | Correct Scanner Y/N |
|---|---|---|---|---|---|
| Flame Scanner | | | | | |

*Maximum allowable timing is 4 sec.
*Only a UV– Self checking scanner is allowed. If scanner is IR, system must be replaced.
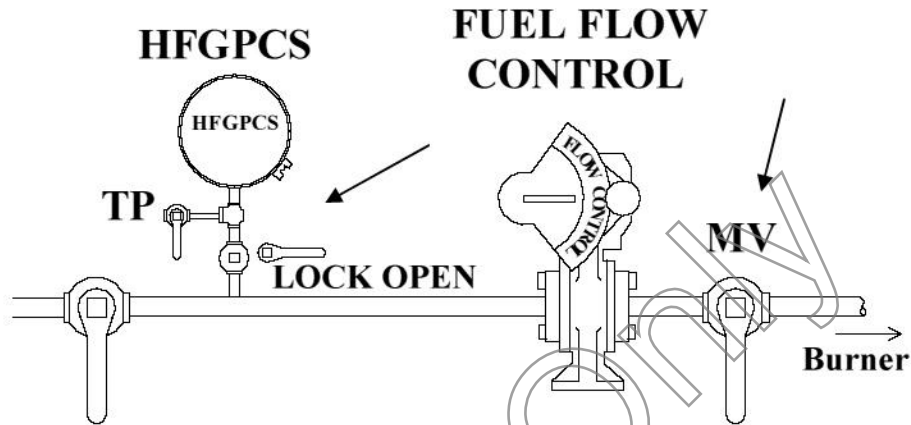


- Close the lockable manual valve between the fuel line and the HFGPCS.
- Quickly close the manual valve in fuel line before burner.
- Observe the time required for the flame scanner to close the automatic fuel safety shutoff valves. (Valves should close within 3 to 4 seconds from the time the flame goes out in the firebox).

| Result | Y/N | Time (seconds) |
|---|---|---|
| Did the scanner work correctly? | | |
| Time to close fuel valves? | | |

Comment:

# Checklist for Flame Scanner Not Sensing Igniter Spark (FSNSIS)

| Item | Make | Model | Rebuilt Y/N |
|------|------|-------|-------------|
| Programmer | | | |

*The scanner should not indicate a voltage-voltage indicates that scanner senses spark.

- Close manual valves in main fuel line and pilot gas line.
- Attempt to start boiler.
- Determine if the scanner output indicates a voltage.

| Result | Y/N |
|--------|-----|
| Did the scanner work correctly? | |

Comment:

# Checklist for Igniter Timing (IT)

| Item | Make | Model |
|------|------|-------|
| Programmer | | |

\* Maximum allowable duration is 10 sec.

- Close manual valves in main fuel line and pilot gas line.
- Start boiler.
- View igniter by means of furnace front or back view port and time the ignition spark. (You can hear the igniter click on and off so that it may not be necessary to view the spark if not easily visible).
- Observe the duration of the ignition spark with a stop watch.

| Result | Y/N | Time (seconds) |
|--------|-----|----------------|
| Did the scanner work correctly? | | |
| Igniter timing? | | |

Comment:

# Checklist for Main Flame Ignition Timing (MFIT)

| Item | Make | Model |
|---|---|---|
| Programmer | | |

* Maximum timing should be 14 seconds.
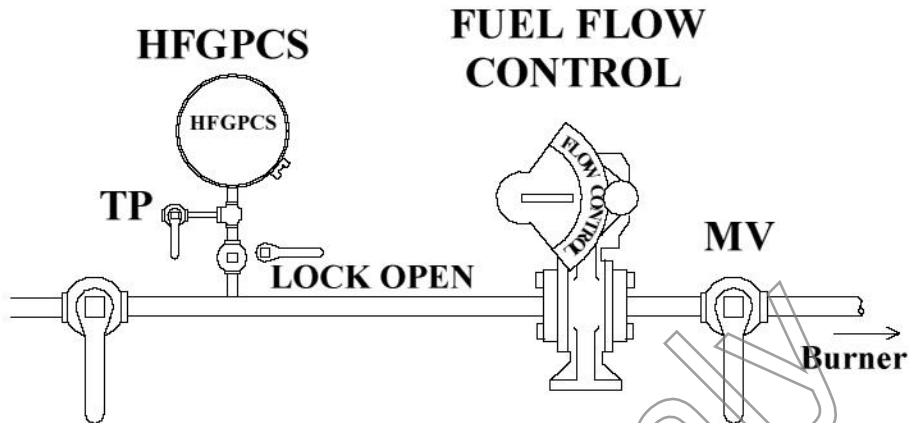


- Close the lockable manual valve between the fuel line and the HFGPCS..
- Close manual valves in main fuel line.
- Attempt to start boiler.
- Time the AFGSOV from the time they begin to open until they close with a stopwatch.

| Result | Y/N | Time (seconds) |
|---|---|---|
| Did the programmer work correctly? | | |
| Time to AFGSOVs? | | |

Comment:

# Checklist for Pre-Purge and Post-Purge Timing (PPT)

| Item | Make | Model | Adjustable Timing Y/N |
|------|------|-------|----------------------|
| Purge Timer | | | |

| Boiler make | Fire Tube / Water tube | Boiler Fireside Volume (ft$^3$) |
|-------------|------------------------|----------------------------------|
| | | |

\* Eight air changes are required for a water tube boiler and 4 air changes for a fire tube boiler.

- Begin firing boiler and record the pre-purge time in the table below.
- Repeat this step for post purge cycle.

| Result | Time (sec) | Y/N |
|--------|-----------|-----|
| Low fire to high fire? | | |
| Time in high fire? | | |
| High fire to low fire? | | |
| Time in post purge? | | |
| Equivalent High Purge Time? | | |
| Is purge adequate? | | |

\*Equivalent purge is all time spent at high fire plus half of the time spent in getting to high fire and returning to low fire.

Comment:

# Checklist for Low-Fire Proving Switch (LFPS)

| Item | Make | Model |
|------|------|-------|
| LFPS | | |

*Should not be made above a 5% point load increase above low fire.
*LFPS must be separate from the control system that modulates the firing rate.

---

- Measure the voltage across the switch during the purge cycle. (The switch should be closed at start up (no voltage) and should open with less than a 5% point increase in load).
- Disconnect one electrical lead from switch. Allow boiler to complete the purge cycle and return to low fire. Boiler should not start.

---

| Result | Y/N | Switch Trip point |
|--------|-----|-------------------|
| Did the switch work correctly? | | |
| What was the switch trip point? | | |

Comment:

# Checklist for Forced Draft Damper Wide-Open Pre-Purge Proving Switch (FDDWOPS)

| Item | Make | Model |
|---|---|---|
| FDDWOPS | | |

* Must be open at positions lower than 90% of wide open (damper vanes).

---

- Measure the voltage across the switch during the purge cycle to determine if the switch is open or closed.  Note load that switch closes.
- Disconnect one electrical lead from switch.  Let boiler go through purge cycle. (Boiler should stay at high purge).

---

| Result | Y/N | Load that switch closes. |
|---|---|---|
| Did the switch work correctly? | | |

Comment:

## Checklist for Combustion Air Pressure Switch (CAPS)

| Item | Make | Low Pressure Tap Location | High Pressure Tap Location | Switch Range (inwc) | Switch Setpoint (inwc) |
|------|------|---------------------------|----------------------------|---------------------|------------------------|
| CAPS | | | | | |

*CAPS should open if pressure drops to 80% of minimum pressure difference.
* If the switch senses the correct pressure difference, the variation in pressure difference from low to high fire will vary only a few percent.
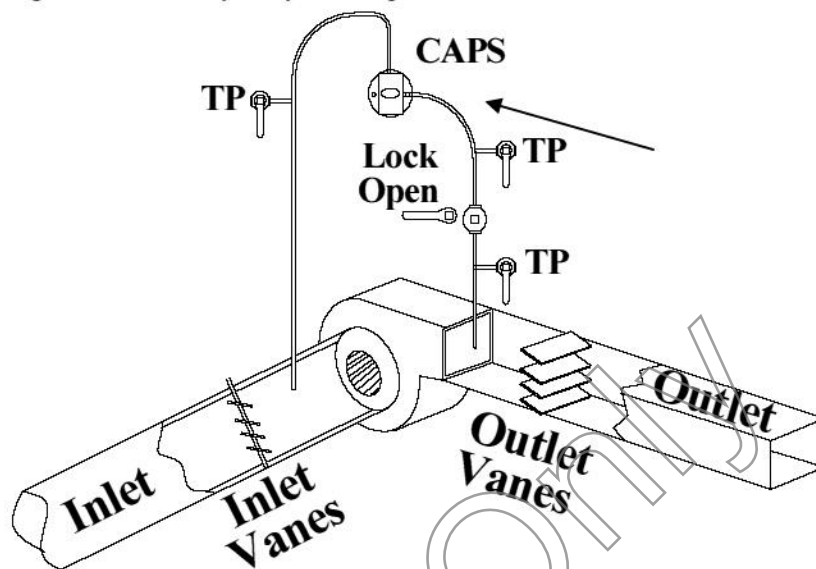


- Install appropriate flex tubing to a manometer from the test ports closest to CAPS to measure the pressure difference that the switch senses by opening the lockable test ports across the switch.
- Start the boiler and record the pressure difference read by manometer from the low fire to high fire position.
- Slowly allow the pressure to drop in the high pressure leg by using the test port closest to the fan outlet and observe the pressure at which the switch opens and shuts off boiler.
- It may be necessary to partially close the Lock Open valve to actuate the switch.
- Record value of pressure difference at which switch tripped.

| Firing Rate | Pressure Difference (inwc) | Minimum Pressure Difference (inwc) | Switch Trip (Break) Point (inwc) |
|-------------|----------------------------|------------------------------------|----------------------------------|
| Low | | | |
| Med | | | |
| High | | | |

*Switch trip point should be 80% of the minimum pressure difference.

| Result | Y/N | Switch Trip (Break) point (inwc) |
|--------|-----|----------------------------------|
| Did the switch work correctly? | | |

Comment:

# Checklist for Purge Airflow Proving Switch (PAPS)

| Item | Make | Low Pressure Tap Location | High Pressure Tap Location | Switch Range (inwc) | Switch Setpoint (inwc) |
|---|---|---|---|---|---|
| PAPS | | | | | |

*Should make at 80% maximum pressure signal.

* If the switch senses the correct pressure difference, the variation in pressure difference at low fire will be small and at high fire will be large.
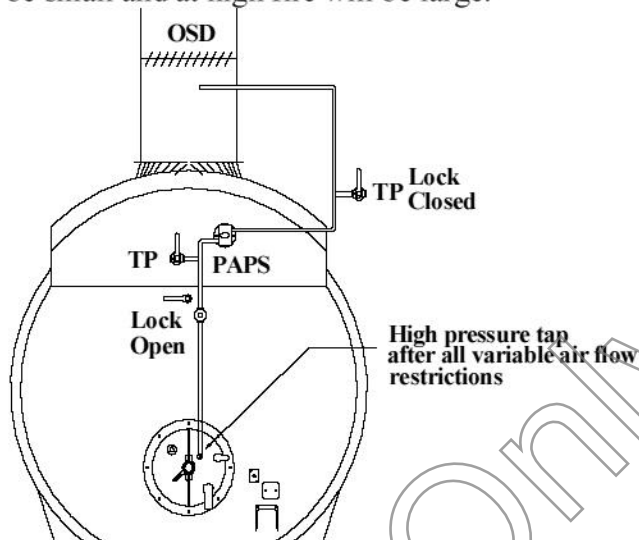


- Connect a manometer to measure the pressure difference that the switch senses by opening the test ports across the switch and installing appropriate flex tubing to the manometer from the test ports.
- Start the boiler and record the pressure difference indicated by manometer from low fire to high fire positions.
- With boiler offline disconnect one lead from the PAPS.
- Close lock open valve and slowly pressurize the high pressure leg with air. Determine switch trip point using a manometer and measuring electrical resistance across the switch.
- With lock open valve open and high pressure leg test port open attempt to restart boiler. Boiler should hold in purge.
- Open lock open valve and close test port. Boiler should light.

| Firing Rate | Pressure Difference | Maximum Pressure Difference (inwc) | Switch Trip (Make) Point (inwc) |
|---|---|---|---|
| Low | | | |
| Med | | | |
| High | | | |

| Result | Y/N | Switch Trip (Make) point (inwc) |
|---|---|---|
| Did the switch work correctly? | | |

Comment:

# Checklist for Forced Draft Motor Interlock Switches (FDMIS)

| Item | Make | Type of Switch: Aux. Contact Phase Monitor Current Relays |
|---|---|---|
| FDMIS | | |

*Current relays are the only acceptable FDMIS

**3 Phase Line In**

**Motor Contactor**

**Current Transformers feeding current relays**

**3 Phase Line Out**
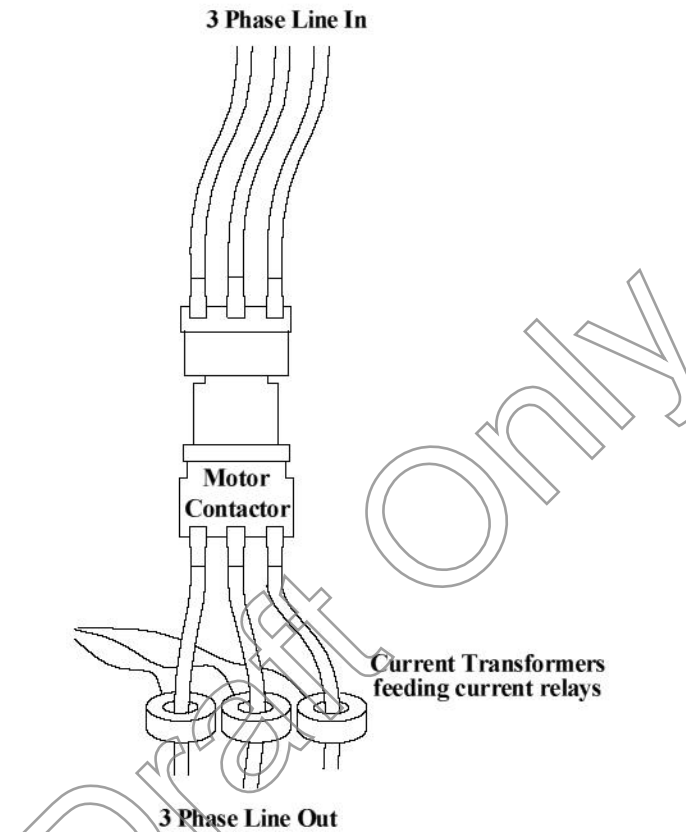
- If current relays are not in place, abort test.
- With power to fan off, remove one electrical power lead to fan from terminal block and slip power lead out of the current transformer ring. Reconnect power lead to fan. (Note some "donut" rings are in form of a clamp and can be removed without disconnecting power lead).
- Attempt to start boiler. Boiler should shut down quickly.
- Repeat above process for each of three power leads to fan.

| Result | Y/N |
|---|---|
| Did the switch work correctly? | |

Comment:

# Checklist for Outlet Stack Damper Interlock Switch (OSDI)

| Item | Make |
|------|------|
| OSDI | |

*Must be open if dampers are not at least 80% open.
*Not required if damper is welded in the wide open position and there are no other potential obstructions.

- Connect a multimeter across the switch and measure voltage.
- Start the boiler and monitor voltage across the switch. The switch should be open (no voltage) until the damper opens to wide open position.
- Stop boiler and turn off power to controls.
- Disconnect one lead from switch.
- Start boiler. The boiler should not complete purge sequence.

| Result | Y/N |
|--------|-----|
| Did the switch work correctly? | |

-

Comment:

# Checklist for Furnace Pressure Interlock (FPI)

| Item | Make | Low Pressure Tap Location | High Pressure Tap Location | Switch Setpoint (inwc) |
|------|------|---------------------------|----------------------------|------------------------|
| FPI  |      |                           |                            |                        |

*Not required on boilers with no outlet stack damper or other possible obstructions in the flue gas outlet system.

*Required trip point is the greater of 1"wc or 20% above maximum boiler furnace pressure.



TP  FPI

Lock Open

**Furnace pressure tap downstream of burner**
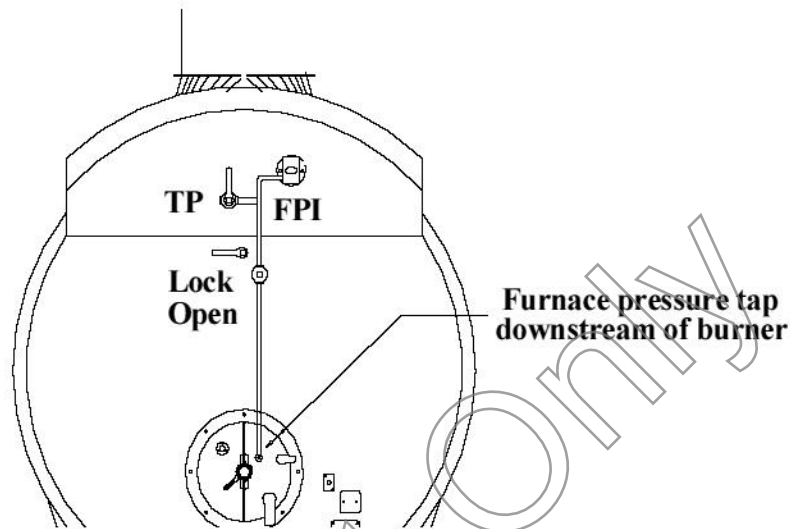
- Open the test port valve and connect a manometer using appropriate flex tubing to the high pressure test port with other side of manometer open to atmosphere.
- Start the boiler and record the pressure sensed by the switch over the entire firing rate.
- Return the boiler to low fire.
- Open the TP valve.
- Close manual lockable valve in high pressure leg.
- Connect flex tubing to TP.
- Slowly pressurize the switch.
- Note the pressure that the boiler trips off line.

| Firing Rate | Pressure Difference | Maximum Pressure Difference (inwc) | Switch Trip Point (inwc) |
|-------------|---------------------|------------------------------------|--------------------------|
| High        |                     |                                    |                          |
| Mid         |                     |                                    |                          |
| Low         |                     |                                    |                          |

* The boiler should trip off line at less than 120% of furnace pressure at high fire.
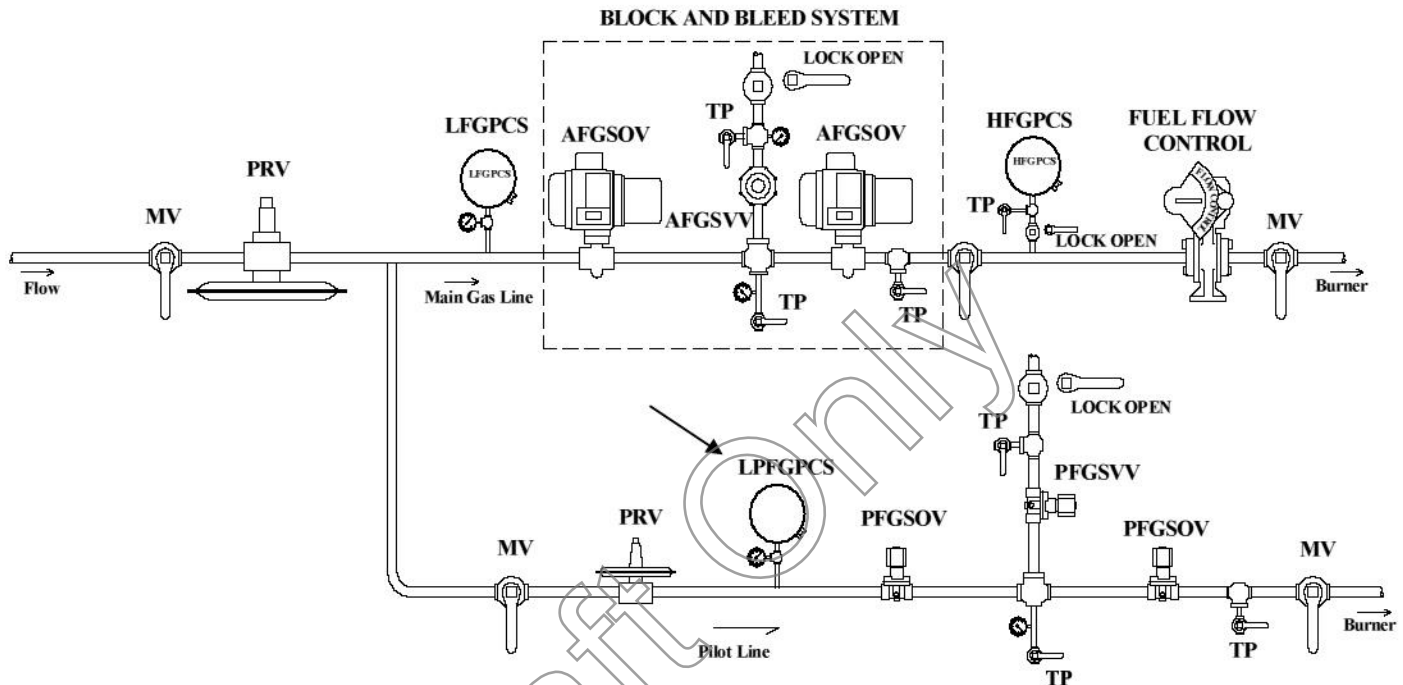
| Result | Y/N | Switch Trip point |
|--------|-----|-------------------|
| Did the switch work correctly? |  |  |

Comment:

# Checklist for Low Pilot Fuel Gas Pressure Cutoff Switch (LPFGPCS)

| Item | Make | Range (inwc/psig) | Switch Setpoint | Regulated Pressure | Correct Location Y/N |
|---|---|---|---|---|---|
| LPFGPCS | | | | | |
| Pressure Gage | | | | | |

*Switch setpoint should be 80% of regulated pressure.



- Close the main fuel valve and allow the pilot burner to light and place programmer in check mode while holding in the pilot cycle.
- In low fire throttle manual valve upstream of the LPFGPCS slowly until switch trips the boiler offline due to low pilot fuel pressure.
- Open the pilot gas valve and again put boiler in check mode with pilot lit. Slowly close the pilot gas valve and regulate the pilot gas pressure to a value just above the trip point.
- Open the main gas valve, place the programmer in the "run" mode, and carefully observe that the main burner ignites immediately and smoothly.
- Be prepared to stop the burner immediately if this does not occur.

| Result | Y/N | Switch Trip point |
|---|---|---|
| Did the boiler light smoothly with low pilot gas pressure? | | |

Comment:

## Checklist for Flue Gas Recirculation Damper Interlock (FGRDI)

| Item | Make |
|------|------|
| FGRDI | |

*Open switch should prevent completion of the pre purge cycle.
*Dampers should be at least 80% open to close the switch.

---

- Connect a multimeter across the switch and measure voltage.
- Start the boiler and monitor voltage across the switch. The switch should be open (no voltage) until the damper opens to wide open position.
- Stop boiler and turn off power to controls
- Disconnect one lead from switch
- Start boiler.  The boiler should not complete the purge sequence.

---

| Result | Y/N | Switch Trip Point |
|--------|-----|-------------------|
| Did the switch work correctly? | | |

Comment:

# Checklist for Low Flue Gas Oxygen Level Interlock (LFGOLI)

**FAIL**

| Item | Make | Alarm or Interlock |
|---|---|---|
| LFGOLI | | |

\*Low oxygen alarm only is inadequate and should be replaced with interlock and alarm.

\*Interlock should prevent boiler from operating with more than 200 ppm CO or combustibles in the flue gass.

- Measure the property values listed in the table below.

| % Load | Steam P (psig) | $O_2$(%) | CO (ppm) | EFF (%) | T-Stack | NOx | Economizer Temp IN | OUT |
|---|---|---|---|---|---|---|---|---|
| Low | | | | | | | | |
| Med | | | | | | | | |
| High | | | | | | | | |

- Use an flue gas analyzer to measure % $O_2$ and CO with the boiler at approximately 30% load.
- Slowly block the boiler air intake or increase fuel without increasing air. USE EXTREME CARE NOT TO CREATE A DANGEROUS CONDITION. NEVER ALLOW THE CO CONTENT OF FLUE GAS TO EXCEED 200 PPM!

| Item | $O_2$% where interlock activated | CO (ppm) where interlock activates |
|---|---|---|
| LFGOLI | | |

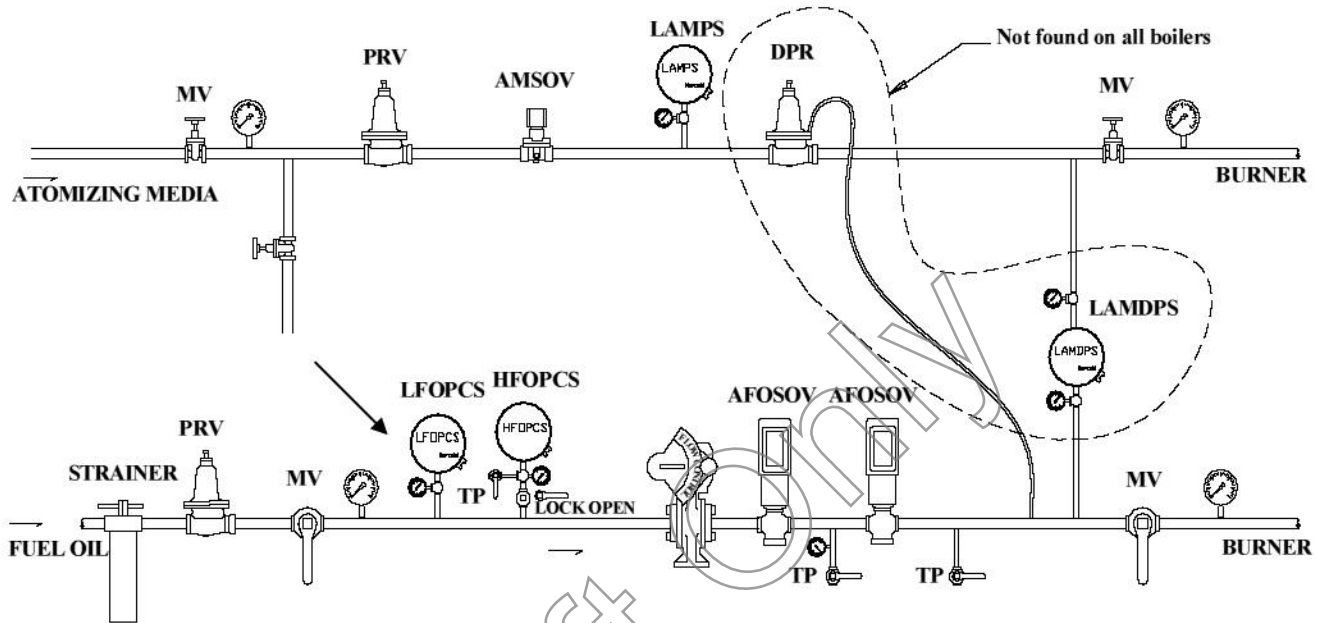| Result | Y/N |
|---|---|
| Did the interlock work correctly? | |
| Did the LFGOLI activate with less than 200 ppm of CO? | |

Comment:

# Checklist for Low Fuel Oil Pressure Cutoff Switch (LFOPCS)

| Item | Make | Range (inwc/psig) | Switch Setpoint | Regulated Pressure | Correct Location Y/N |
|---|---|---|---|---|---|
| LFOPCS | | | | | |
| Pressure Gage | | | | | |

*The LFOPCS location must be downstream of PRV and upstream of flow control valve.

*Trip point of LFOPCS should be equal to or greater than 90% of regulated pressure.



- In low fire, throttle upstream fuel valve slowly until switch trips the boiler offline due to low fuel pressure but NO LOWER THAN 80% OF REGULATED PRESSURE.

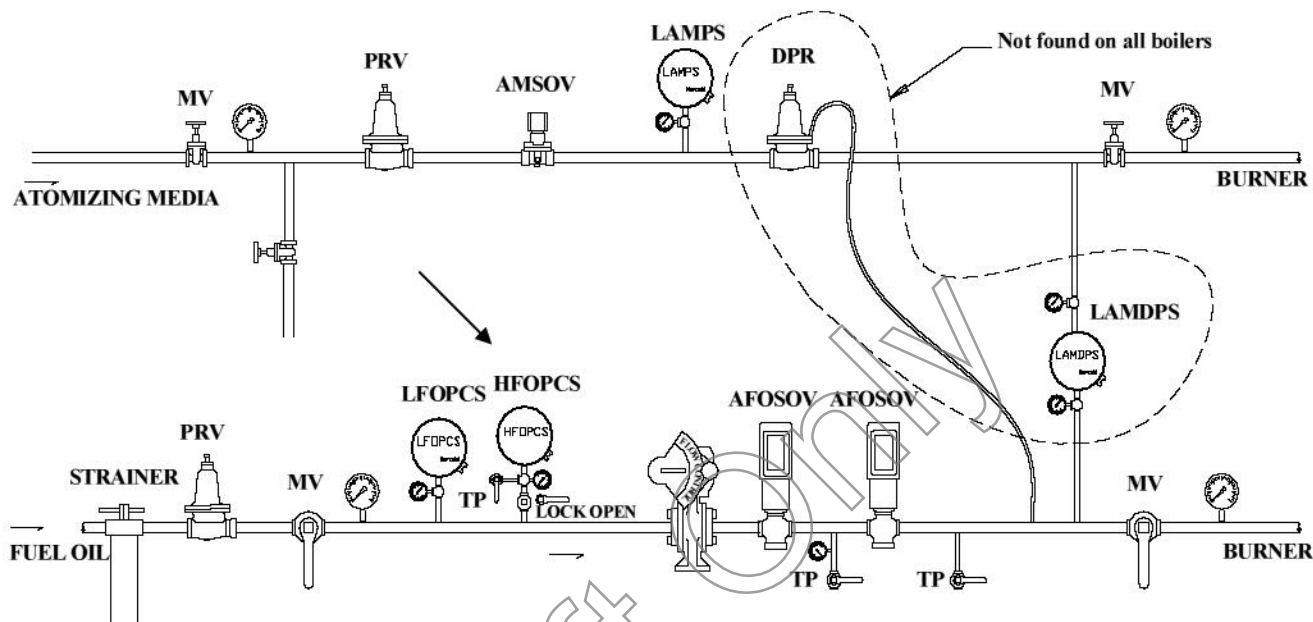| Result | Y/N | Switch Trip point |
|---|---|---|
| Did the switch work correctly? | | |
| Is switch setpoint 90% or more of regulated pressure? | | |

Comment:

## Checklist for High Fuel Oil Pressure Cutoff Switch (HFOPCS)

**FAIL**

| Item | Make | Range (inwc/psig) | Switch Setpoint | Regulated Pressure | Correct Location Y/N |
|------|------|-------------------|-----------------|--------------------|-----------------------|
| HFOPCS | | | | | |
| Pressure Gage | | | | | |

*The HFOPCS location must be downstream of PRV and upstream of flow control valve.
*Trip point of HFOPCS should be equal to or less than 110% of regulated pressure.



- With boiler in low fire close lock open manual valve isolating the HFOPCS.
- Open test port between lockable manual valve and HFOPCS; pressurize switch with compressed air or nitrogen.
- Slowly raise pressure until switch trips boiler offline due to high fuel pressure.

| Result | Y/N | Switch Trip Point |
|--------|-----|-------------------|
| Did the switch work correctly? | | |
| Is switch setpoint 110% or less of regulated pressure? | | |

Comment:

# Checklist for Low Atomizing Media Pressure Switch (LAMPS)

| Item | Pressure |
|---|---|
| Atomizing media pressure at low fire | |

| Item | Make | Range (inwc/psig) | Switch Setpoint | Regulated Pressure | Correct Location Y/N |
|---|---|---|---|---|---|
| LAMPS | | | | | |
| Pressure Gage | | | | | |

*Setpoint Should be 80% or more of atomizing media pressure at low fire
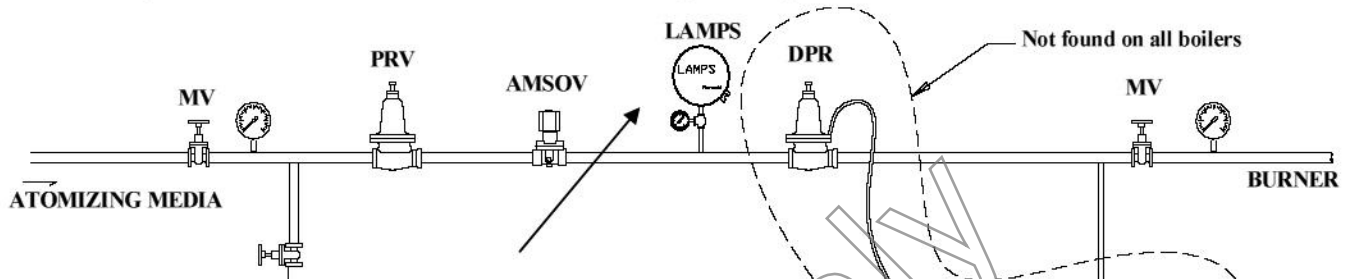


- Operate boiler and determine data in following table.

| Item | Minimum Fire (psig) | Mid Fire (psig) | High Fire (psig) |
|---|---|---|---|
| Oil pressure at burner | | | |
| Atomizing Pressure at burner | | | |
| Oil pressure downstream PRV | | | |
| Atomizing pressure downstream PRV | | | |

- In low fire throttle manual valve in atomizing media line before the switch slowly until switch trips the boiler offline due to low atomizing media pressure but NO LOWER THAN 80% OF ATOMIZING MEDIA PRESSURE AT LOW FIRE.

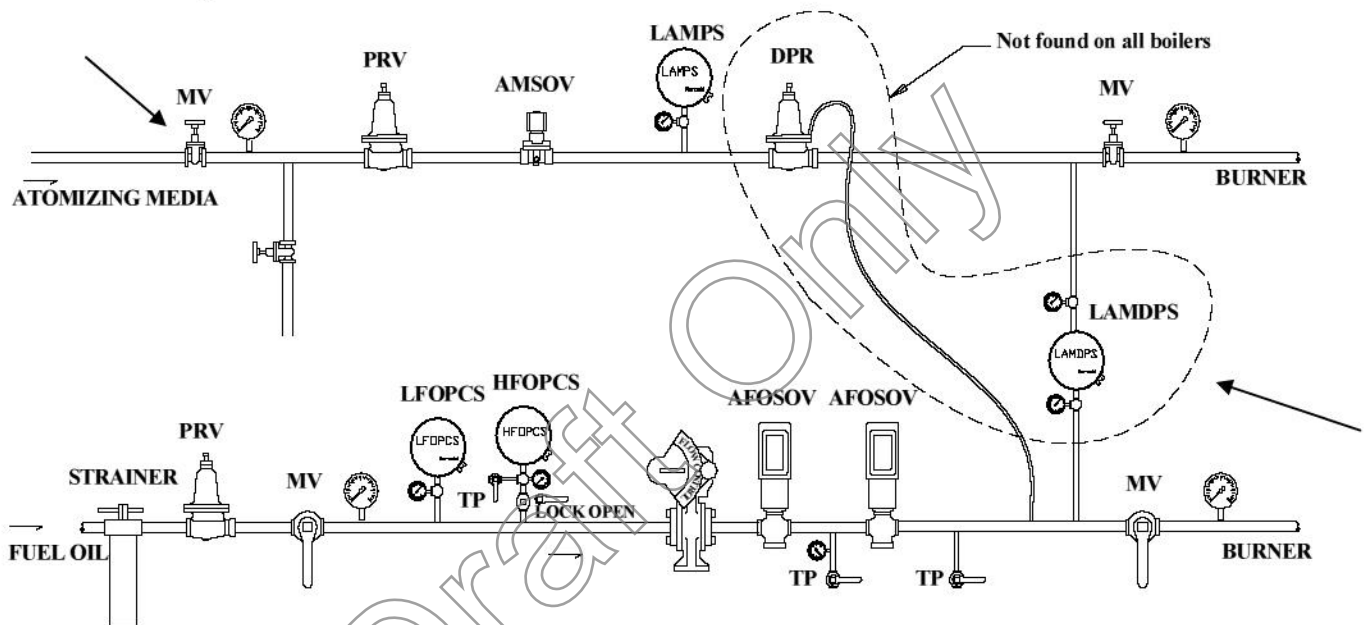| Result | Y/N | Switch Trip Point |
|---|---|---|
| Did the switch work correctly? | | |

Comment:

# Checklist for Low Atomizing Media Differential Pressure Switch (LAMDPS)

| Item | Make | Range (inwc/PSIG) | Switch Setpoint | Minimum Diff Pressure | Correct Location Y/N |
|---|---|---|---|---|---|
| LAMDPS | | | | | |
| Pressure Gage Fuel Oil Burner | | | | | |
| Pressure Gage Atomizing media | | | | | |

\*This switch is not required if oil pressure exceeds atomizing pressure at any firing rate.
\*For this case the LOLI is the only protection against inadequate atomizing media.
\*Setpoint should be 80% or more of minimum differential pressure between oil and atomizing media.



- Determine the minimum differential pressure from data table in LAMPS checklist and record in above table.
- In low fire throttle manual valve in atomizing media line before the LAMDPS slowly until switch trips the boiler offline due to low differential pressure but NO LOWER THAN 80% OF MINIMUM ATOMIZING MEDIA DIFFERENTIAL PRESSURE.
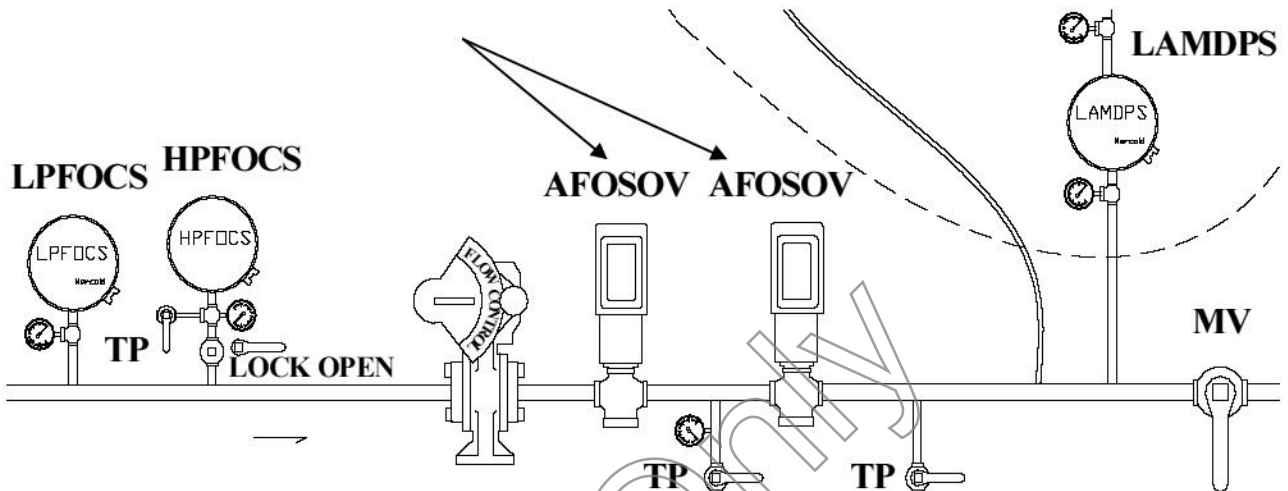
| Result | Y/N | Switch Trip point |
|---|---|---|
| Did the switch work correctly? | | |

Comment:

## Checklist for Automatic Fuel Oil Shutoff Valves (AFOSV) - for Seat Leakage

| Item | Make | Range (inwc/psig) | Correct Installation Y/N |
|------|------|-------------------|--------------------------|
| AFOSV | | | |
| Pressure Gage | | | |

*After equilibrium is established, leak rate should be less than one drop in 10 seconds.



- While the boiler is firing quickly close the manual valve in oil line located after the automatic shut off valves.
- Place a container under the test port downstream of both automatic shut off valves. Open the downstream test port valve and observe oil flow. In order to consider the valve as not leaking, oil should be less than 1 drop in 10 seconds. Some time is needed to establish equilibrium. Make sure that the pressure gage between the 2 auto shut off valves indicates pressure approximately equal to regulated pressure or higher. If downstream shut off valve leaks this pressure will fall.
- Place a container under the test port between the automatic shut off valves. Open the downstream test port valve between the automatic shut off valves and observe oil flow. In order to consider the valve as not leaking, oil flow should be less than 1 drop in 10 seconds. Some time is needed to establish equilibrium.

| Result | Y/N |
|--------|-----|
| Did upstream AFOSV leak? | |
| Did downstream AFOSF leak? | |

Comment:

# Checklist for Proof of Closure on Automatic Fuel Oil Shutoff Valves (POC-AFOSV) – Oil

| Item | Make |
|---|---|
| POC-AFOSV | |

*Switch should open with a very slight opening of the valve.
*Switches on the two valves must be wired in series.

---

- Close manual fuel valve downstream of AFOSOV. Perform the following test on each AFOSOV separately.
- Remove cover on both automatic shut off valves to provide access to two wires connected across proof of closure switch. Can also access wires in appropriate junction box. Disconnect both leads from switch going to control circuit.
- Temporarily connect the wires disconnected from the POC switch in order to bypass the switch.
- Start boiler and verify that switch opens with a very slight opening of the valve by measuring resistance across switch.
- Shut boiler down and disconnect two wires going to control circuit. Try to start boiler and verify that the boiler does not allow ignition sequence to begin.
- Repeat procedure for switch on 2nd valve.

---

| Result | Y/N |
|---|---|
| Is proof of closure present in both valves? | |
| Did either valve being open allow the boiler to fire? | |
| Did both switches open with very slight opening of valve? | |

Comment:

# Checklist for Oil Burner Position Switch (OBPS)

| Item | Make |
|------|------|
| OBPS | |

*If no switch is present this test is not required and test is complete.

- Retract the gun enough to disengage the switch. Attempt to start the boiler. The boiler controls should not allow the purge process to begin. IF BOILER BEGINS TO MOVE TO THE PURGE POSTION SHUT THE BOILER DOWN IMMEDIATELY. IN THIS CASE THE OBPS SWITCH IS DEFECTIVE.

| Result | Y/N |
|--------|-----|
| Did the switch work correctly? | |

Comment: